THE JOURNAL
OF
ANIMAL ECOLOGY

EDITED FOR THE

BRITISH ECOLOGICAL SOCIETY

BY

L. R. TAYLOR AND J. M. ELLIOTT

EDITORIAL BOARD

T. H. CLUTTON-BROCK, R. M. CORMACK,
N. B. DAVIES, G. M. DUNNET, M. P. HASSELL,
C. J. KREBS, J. R. KREBS, R. H. K. MANN,
A. D. McINTYRE, J. N. PERRY, D. J. ROGERS,
J. B. WHITTAKER

VOLUME 56
1987

BLACKWELL SCIENTIFIC PUBLICATIONS
OXFORD LONDON EDINBURGH
BOSTON PALO ALTO MELBOURNE
1987

PUBLISHED BY BLACKWELL SCIENTIFIC PUBLICATIONS LTD, OSNEY MEAD, OXFORD

This journal is covered by *Current Contents, ASCA* and *Science Citation Index*.

© 1987 British Ecological Society. Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by The British Ecological Society for libraries and other users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the base fee of $03.00 per copy is paid directly to CCC, 27 Congress Street, Salem, MA 01970, U.S.A. Special requests should be addressed to the Editor.
0021-8790/87 $03.00

Printed in Great Britain at The Alden Press, Oxford

CONTENTS

ORIGINAL PAPERS PAGE

Adams, E. S. and **Levings, S. C.** Territory size and population limits in mangrove termites 1069

Albon S. D., Clutton-Brock, T. H. and **Guinness, F. E.** Early development and population dynamics in red deer. II. Density-independent effects and cohort variation 69

Albon, S. D. See **Clutton-Brock, T. H.**

Aldridge, H. D. J. N. and **Rautenbach, I. L.** Morphology, echolocation and resource partitioning in insectivorous bats 763

Ayal, Y. The foraging strategy of *Diaretiella rapae*. I. The concept of the elementary unit of foraging 1057

Banks, M. J. and **Thompson, D. J.** Lifetime reproductive success of females of the damselfly *Coenagrion puella* 815

Bauer, G. Reproductive strategy of the freshwater pearl mussel *Margaritifera margaritifera*. 691

Birley, M. H. See **Holmes, P. R.**

Bonaccorso, F. J. and **Gush, T. J.** Feeding behaviour and foraging strategies of captive phyllostomid fruit bats: an experimental study 907

Boonstra, R., Krebs, C. J. Gaines, M. S., Johnson, M. L. and **Craine, I. T. M.** Natal philopatry and breeding systems in voles (*Microtus* spp.) . . . 655

Brooke, M. de L. and **Davies, N. B.** Recent changes in host usage by cuckoos *Cuculus canorus* in Britain 873

Carvalho, G. R. and **Crisp, D. J.** The clonal ecology of *Daphnia magna* (Crustacea: Cladocera). I. Temporal changes in the clonal structure of a natural population 453

Carvalho, G. R. The clonal ecology of *Daphnia magna* (Crustacea: Cladocera). II. Thermal differentiation among seasonal clones 469

Caughley, G., Short, J., Grigg, G. C. and **Nix, H.** Kangeroos and climate: an analysis of distribution 751

Clobert, J. See **Weimerskirch, H.**

Clutton-Brock, T. H., Albon, S. D. and **Guinness, F. E.** Interactions between population density and maternal characteristics affecting fecundity and juvenile survival in red deer 857

Clutton-Brock, T. H., Major, M., Albon, S. D. and **Guinness, F. E.** Early development and population dynamics in red deer. II. Density-dependent effects on juvenile survival 53

Clutton-Brock, T. H. See **Albon, S. D.**

Coulson, J. C. See **Porter, J. M.**

Cowan, D. P. Group living in the European rabbit (*Oryctolagus cuniculus*): mutual benefit or resource localization? 779

Craine, I. T. M. See **Boonstra, R.**

Crisp, D. J. See **Carvalho, G. R.**

Davies, N. B. See **Brooke, M. de L.**

Delbeek, J. C. and **Williams, D. D.** Food resource partitioning between sympatric populations of brackishwater sticklebacks 949

Desharnais, R. A. and **Liu, L.** Stable demographic limit cycles in laboratory populations of *Tribolium castaneum* 885
Dickman, C. R. and **Doncaster, C. P.** The ecology of small mammals in urban habitats. I. Populations in a patchy environment 629
Dixon, A. F. G. See **Wellings, P. W.**
Doncaster, C. P. See **Dickman, C. R.**
Draulans, D. The effect of prey density on foraging behaviour and success of adult and first-year grey herons (*Ardea cinerea*) 479
Durell, S. E. A. le V. dit See **Goss-Custard, J. D.**
Earle, W. M. See **Innes, S.**
Elliott, J. M. Population regulation in two contrasting populations of trout *Salmo trutta* in two Lake District streams 83
Elliott, J. M. Egg hatching and resource partitioning in stoneflies: the six British *Leuctra* spp. (Plecoptera: Leuctridae) 415
Elmes, G. W. Temporal variation in colony populations of the ant *Myrmica sulcinodis*. I. Changes in queen number, worker number and spring production 559
Elmes, G. W. Temporal variation in colony populations of the ant *Myrmica sulcinodis*. II. Sexual production and sex ratios 573
Finke, M. A., Milinkovich, D. J. and **Thompson, C. F.** Evolution of clutch size: an experimental test in the house wren (*Troglodytes aedon*) 99
Fitzgerald, G. J. See **Whoriskey, F. G.**
Fox, B. J. See **Haering, R.**
Gaines, M. S. See **Boonstra, R.**
Galindo, C. and **Krebs, C. J.** Population regulation in deer mice: the role of females 11
Gauthier, G. and **Smith, J. N. M.** Territorial behaviour, nest site availability, and breeding density in buffleheads 171
Gibbons, D. W. Hatching asynchrony reduces parental investment in the jackdaw 403
Gibbs, H. L. and **Grant, P. R.** Adult survivorship in Darwin's ground finch (*Geospiza*) populations in a variable environment 797
Gordon, I. J. See **Illius, A. W.**
Goss-Custard, J. D. and **Durell, S. E. A. le V. dit** Age-related effects in oystercatchers, *Haematopus ostralegus*, feeding on mussels, *Mytilus edulis*. I. Foraging 521
Goss-Custard, J. D. and **Durell, S. E. A. le V. dit** Age-related effects in oystercatchers, *Haematopus ostralegus*, feeding on mussels. *Mytilus edulis*. II. Aggression 537
Grant, J. W. A. and **Noakes, D. L. G.** Movers and stayers: foraging tactics of young-of-the-year brook charr, *Salvelinus fontinalis* 1001
Grant, P. R. See **Gibbs, H. L.**
Griffiths, R. A. Microhabitat and seasonal niche dynamics of smooth and palmate newts, *Triturus vulgaris* and *T. helveticus*, at a pond in Wales . 441
Grigg, G. C. See **Caughley, G.**
Guinness, F. E. See **Albon, S. D.**
Guinness, F. E. See **Clutton-Brock, T. H.**
Gush, T. J. See **Bonaccorso, F. J.**

Haering, R. and **Fox, B. J.** Short-term coexistence and long-term competitive displacement of two dominant species of *Iridomyrmex*: the successional response of ants to regenerating habitats 495
Hannon, S. J., Mumme, R. L., Koenig, W. D., Spon, S. and **Pitelka, F. A.** Poor acorn crop, dominance and decline in numbers of acorn woodpeckers . 197
Hassell, M. P. Detecting regulation in patchily distributed animal populations 705
Hassell, M. P., Southwood, T. R. E. and **Reader, P. M.** The dynamics of the viburnum whitefly (*Aleurotrachelus jelinekii*): a case study of population regulation 283
Heads, P. A. See **Lawton, J. H.**
Hildrew, A. G. See **Townsend, C. R.**
Holmes, P. R. and **Birley, M. H.** An improved method for survival rate analysis from time series of haematophagous Dipteran populations 427
Hubbard, S., Marris, G., Reynolds, A. and **Rowe, G.** Adaptive patterns in the avoidance of superparasitism by solitary parasitic wasps 387
Hutton, J. M. Growth and feeding ecology of the Nile crocodile *Crocodylus niloticus* at Ngezi, Zimbabwe 25
Illius, A. W. and **Gordon, I. J.** The allometry of food intake in grazing ruminants 989
Ims, R. A. Responses in spatial organization and behaviour to manipulations of the food resource in the vole *Clethrionomys rufocanus* 585
Innes, S., Lavigne, D. M., Earle, W. M. and **Kovacs, K. M.** Feeding rates of seals and whales 115
Ives, P. M. See **Jones, R. E.**
Johnson, M. L. See **Boonstra, R.**
Jones, G. Time and energy constraints during incubation in free-living swallows (*Hirundo rustica*): an experimental study using precision electronic balances 229
Jones, R. E., Nealis, V. G., Ives, P. M. and **Scheermeyer, E.** Seasonal and spatial variation in juvenile survival of the cabbage butterfly *Pieris rapae*: evidence for patchy density dependence 723
Jones, R. E. Ants, parasitoids, and the cabbage butterfly *Pieris rapae* . . . 739
Jouventin, P. See **Weimerskirch, H.**
Juliano, S. A. and **Williams, F. M.** A comparison of methods for estimating the functional response parameters of the random predator equation . . . 641
Koenig, W. D. See **Hannon, S. J.**
Korpimäki, K. Selection for nest-hole shift and tactics of breeding dispersal in Tengmalm's owl *Aegolius funereus* 185
Kovacs, K. M. See **Innes, S.**
Krebs, C. J. See **Boonstra, R.**
Krebs, C. J. See **Galindo, C.**
Kruuk, H. H. and **Parish, T.** Changes in the size of groups and ranges of the European badger (*Meles meles* L.) in an area in Scotland 351
Lakhani, K. H. Efficient estimation of age-specific survival rates from ring recovery data of birds ringed as young, augmented by field information . 969
Lavigne, D. M. See **Innes, S.**
Lawton, J. H., MacGarvin, M. and **Heads, P. A.** Effects of altitude on the abundance and species richness of insect herbivores on bracken . . . 147
Levings, S. C. See **Adams, E. S.**

Longino, J. T. See **Mallet, J.**
Lundberg, P. Breeding seasons of North Scandinavian starlings (*Sturnus vulgaris*): constrained by food or time? 847
MacGarvin, M. See **Lawton, J. H.**
McRoberts, R. E. See **Mech, L. D.**
Magor, J. I. See **Rosenberg, L. J.**
Major, M. See **Clutton-Brock, T. H.**
Mallet, J., Longino, J. T., Murawski, D., Murawski, A. and **Simpson de Gamboa, A.** Handling effects in *Heliconius*: Where do all the butterflies go? . . . 377
Marris, G. See **Hubbard, S.**
Mech, L. D., McRoberts, R. E., Peterson, R. O. and **Page, R. E.** Relationship of deer and moose populations to previous winters' snow 615
Milinkovich, D. J. See **Finke, M. A.**
Mumme, R. L. See **Hannon, S. J.**
Murawski, A. See **Mallet, J.**
Murawski, D. See **Mallet, J.**
Møller, H. See **Smith, R. H.**
Nachman, G. Systems analysis of acarine predator–prey interactions. I. A stochastic simulation model of spatial processes 247
Nachman, G. Systems analysis of acarine predator–prey interactions. II. The role of spatial processes in system stability 267
Nealis, V. G. See **Jones, R. E.**
Nilsson, S. G. Limitation and regulation of population density in the nuthatch *Sitta europaea* (Aves) breeding in natural cavities 921
Nix, H. See **Caughley, G.**
Noakes, D. L. G. See **Grant, J. W. A.**
Nol, E. and **Smith, J. N. M.** Effects of age and breeding experience on seasonal reproductive success in the song sparrow 301
Page, R. E. See **Mech, L. D.**
Peterson, R. O. See **Mech, L. D.**
Pitelka, F. A. See **Hannon, S. J.**
Porter, J. M. and **Coulson, J. C.** Long-term changes in recruitment to the breeding group, and the quality of recruits at a kittiwake *Rissa tridactyla* colony 675
Rautenbach, I. L. See **Aldridge, H. D. J. N.**
Reader, P. M. See **Hassell, M. P.**
Reynolds, A. See **Hubbard, S.**
Rosenberg, L. J. and **Magor, J. I.** Predicting windborne displacements of the brown planthopper, *Nilaparvata lugens* from synoptic weather data. I. Long-distance displacements in the north-east monsoon 39
Rowe, G. See **Hubbard, S.**
Sæther, B.-E. See **Vivås, H. J.**
Scheermeyer, E. See **Jones, R. E.**
Schmid-Hempel, P. Efficient nectar-collecting by honeybees. I. Economic models 209
Schmid-Hempel, P. Efficient nectar-collecting by honeybees. II. Response to factors determining nectar availability 219
Schofield, K. See **Townsend, C. R.**

Short, J. See **Caughley, G.**
Sibly, R. M. See **Smith, R. H.**
Simmons, L. W. Competition between larvae of the field cricket, *Gryllus bimaculatus* (Orthoptera: Gryllidae) and its effects on some life-history components of fitness 1015
Simpson de Gamboa, A. See **Mallet, J.**
Smith, J. N. M. See **Gauthier, G.**
Smith, R. H., Sibly, R. M. and **Møller, H.** Control of size and fecundity in *Pieris rapae*: towards a theory of butterfly life cycles 341
Smith, J. N. M. See **Nol. E.**
Southwood, T. R. E. See **Hassell, M. P.**
Spelling, S. M. and **Young, J. O.** Predation on lake-dwelling leeches (Annelida: Hirudinea): an evaluation by field experiment 131
Spon. S. See **Hannon, S. J.**
Thompson, C. F. See **Finke, M. A.**
Thompson, D. J. See **Banks, M. J.**
Tokeshi, M. and **Townsend, C. R.** Random patch formation and weak competition: coexistence in an epiphytic chironomid community . . . 833
Townsend, C. R., Hildrew, A. G. and **Schofield, K.** Persistence of stream invertebrate communities in relation to environmental variability . . . 597
Townsend, C. R. See **Tokeshi, M.**
Vivås, H. J. and **Sæther, B-E.** Interactions between a generalist herbivore, the moose *Alces alces*, and its food resources: an experimental study of winter foraging behaviour in relation to browse availability 509
Weimerskirch, H., Clobert, J. and **Jouventin, P.** Survival in five southern albatrosses and its relationship with their life history 1043
Wellings, P. W. and **Dixon, A. F. G.** Sycamore aphid numbers and population density. III. The role of aphid-induced changes in plant quality . . . 161
Whoriskey, F. G. and **Fitzgerald, G. J.** Intraspecific competition in sticklebacks (Gasterosteidae: Pisces): does mother nature concur? 939
Williams, D. D. See **Delbeek, J. C.**
Williams, F. M. See **Juliano, S. A.**
Willows, R. I. Population dynamics and life history of two contrasting populations of *Ligia oceanica* (Crustacea: Oniscidae) in the rocky supralittoral 315
Willows, R. I. Intrapopulation variation in the reproductive characteristics of two populations of *Ligia oceanica* (Crustacea: Oniscidae) 331
Wilson, E. O. Causes of ecological success: the case of the ants. The Sixth Tansley Lecture 1
Yamada, Y. Factors determining the rate of parasitism by a parasitoid with a low fecundity, *Chrysis shanghaiensis* (Hymenoptera: Chrysididae) 1029
Young, J. O. See **Spelling, S. M.**

OBITUARIES

Sir Alister Hardy, F.R.S. 365
H. N. Southern 715

REVIEWS AND SHORT NOTICES

Ahmadjian, V. and **Parcer, S.** Symbols. An Introduction to Biological Associations . . . 1090
Ali, S. The Fall of a Sparrow . . . 375
Andersson, F. and **Olsson, B.** (Eds) Lake Gårdsjön: An Acid Forest Lake and its Catchment . . . 375
Berger, J. Wild Horses of the Great Basin: Social Competition and Population Size . . . 375
Bjärwall, A. and **Ullström, S.** The Mammals of Britain and Europe . . . 721
du Chatenet, G. Guide des Coléoptères d'Europe . . . 721
Clarke, R. (Ed.) The Handbook of Ecological Monitoring . . . 1091
Cook, L. M. (Ed.) Case Studies in Population Biology . . . 719
Digby, P. G. N. and **Kempton, R. A.** Multivariate Analysis of Ecological Communities . . .
Ehrlich, P. R. The Machinery of Nature. The Living World Around Us and How it Works . . . 369
Ekkerhard, F. Breeding Butterflies and Moths . . . 1091
Eldredge, N. Unfinished Synthesis: Biological Hierarchies and Modern Evolutionary Thought . . . 721
Endler, J. A. Natural Selection in the Wild . . . 719
Estrada, A. and **Fleming, T. H.** (Eds) Frugivores and Seed Dispersal . . . 721
Flowerdew, J. R., Gurnell, J. and **Gipps, J. H. W.** (Eds) The Ecology of Woodland Rodents, Bank Voles and Wood Mice . . . 370
Gibbs, A. and **Meische, R.** (Eds) Pests and Parasites as Migrants . . . 721
Gilbert, F. S. Hoverflies . . . 721
Goodall, J. The Chimpanzees of Gombe: Patterns of Behaviour . . . 721
Halam, T. G. and **Levin, S. A.** (Eds) Mathematical Ecology: An Introduction Vol. 17. . . . 1083
Harris, M. The Aurelian . . . 375
Hellawell, J. M. Biological Indicators of Freshwater Pollution and Environmental Management . . . 1084
Heller, H. (Ed.) Verhandlungen, Gesellschaft für Ökologie . . . 375
Henry, J. D. Red Fox: The Catlike Canine . . . 1085
Hilty, S. L. and **Brown, W. L.** Birds of Columbia . . . 722
Hughes, R. N. A Functional Biology of Marine Gastropods . . . 370
Jackson, J. B. C., Buss, L. W. and **Cook, R. E.** (Eds) Population Biology and the Evolution of Clonal Organisms . . . 722
Karlin, S. and **Nevo, E.** Evolutionary Processes and Theory . . . 722
King, C. Immigrant Killers, Introduced Predators and the Conservation of Birds in New Zealand . . . 371
Knight, D. The Age of Science . . . 1091
Kohn, A. False Prophets . . . 1091
Lampert, L. Food Limitations and the Structure of Zooplankton Communities 1086
Levins, R. and **Lewontin, R. C.** The Dialectical Biologist . . . 1087
Lounibos, L. P., Rey, J. R. and **Frank, J. H.** (Eds) Ecology of Mosquitoes: Proceedings of a Workshop . . . 372
Manley, B. J. F. The Statistics of Natural Selection on Animal Populations . 373

Montgomery, G. G. (Ed.) Evolution and Ecology of Armadillos, Sloths and Vermilinguas 376
Neal, E. The Natural History of Badgers 376
Newton, I. The Sparrowhawk 373
O'Connor, R. and **Shrubb, M.** Farming and Birds 1087
Olney, P. J. S. (Ed.) International Zoo Yearbook 24/25 1087
Owen, M., Atkinson-Wills, G. L. and **Salmon, D. G.** Wildfowl in Great Britain. 1091
Pianka, E. R. Ecology and Natural History of Desert Lizards 1088
Pitcher, T. J. (Ed.) The Behaviour of Teleost Fishes 373
Pollard, E., Hall, M. L. and **Bibby, T. J.** Monitoring the Abundance of Butterflies 1091
Press, W. H., Flannery, B. P., Teukolsky, S. A. and **Vettering, W. T.** Numerical Recipes: The Art of Scientific Computing 374
Provine, W. B. Sewall Wright and Evolutionary Biology 720
Rankin, M. A. (Ed) Migration: Mechanisms and Adaptive Significance . . 722
Ransom, R. and **Matela, R. J.** Computor Graphics in Biology 1091
Raven, C. E. John Ray: Naturalist 722
Richardson, R. D. Henry Thoreau 1092
Ridpath, M. G. and **Corbett, L. K.** (Eds) Ecology of the Wet–Dry Tropics. . 376
Sawyer, R. T. Leech Biology and Behaviour 720
Sibly, R. M. and **Calow, P.** Physiological Ecology of Animals 1088
Smart, M. M., Lubinski, K. S. and **Schnick, R. A.** Ecological Perspectives of the Upper Mississippi River 1092
Tauber, M. J., Tauber, C. A. and **Masaki, S.** Seasonal Adaptations of Insects 374
Upton, G. & Fingleton, B. Spatial Data Analysis by Example. Vol. I. Point Pattern and Quantitative Data 722
Usher, M. B. (Ed.) Wildlife Conservation Evaluation 376
Wharton, D. A Functional Biology of Nematodes 376
Wynne-Edwards, V. C. Evolution Through Group Selection 1089